

Enabling a national road and street database in population statistics

Pasi Piela

pasi.piela@stat.fi

ESRI UC San Diego 2014

Accessibility applications

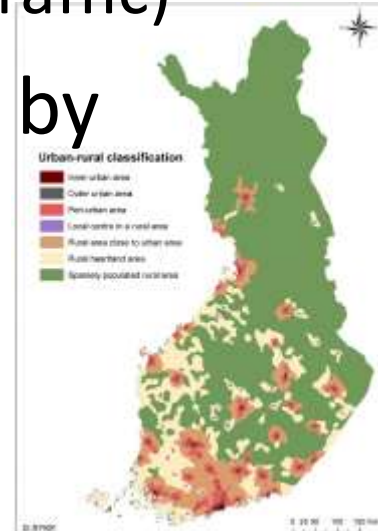
- Commuting distances
 - General annual update for the Social Statistics Data Warehouse
- Commuting time
 - Enriching with traffic sensor data
- Other applications
 - Emergency 24/7 accessibility
 - Elementary school accessibility

Data and contextual issues 1/2

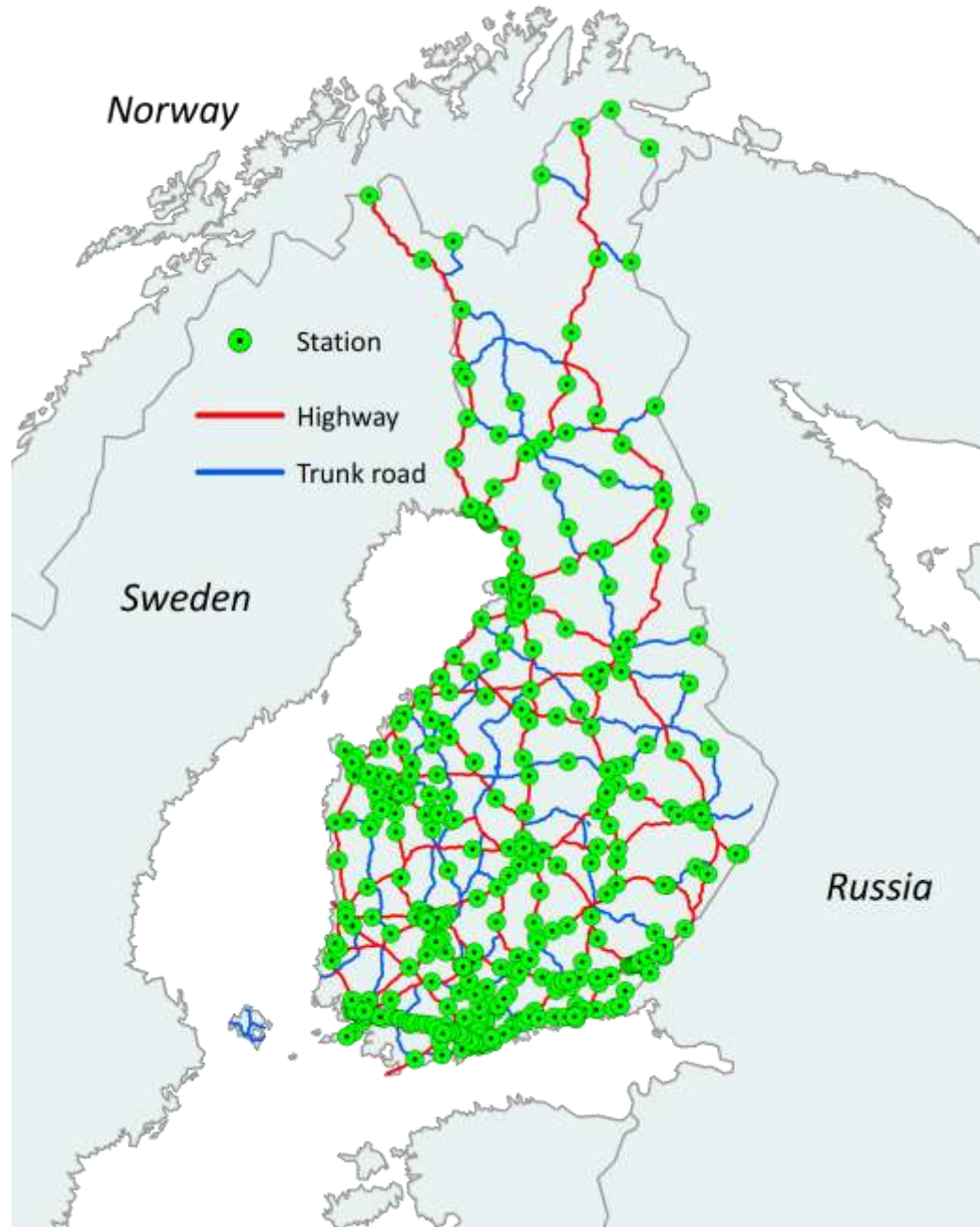
- Digiroad, National Road Database of Finnish Transport Agency
 - accurate data on the location of all roads and streets in Finland
- Social Statistics Data Warehouse of StatFi
 - Dwelling coordinates and work place coordinates (2 years lag) along with a variety of demographic features.
 - Coordinate coverage for the "workplace" was 91.2% of all employed inhabitants in 2011.

Data and contextual issues 2/2

- Traffic sensor detection data of FTA
 - Currently 437 stations (vehicle detection loops) giving information for speed, direction, length and class of a passing vehicle. Target here: speed of passenger cars excluding heavy vehicles.
 - Open data services available as well (Digitraffic)
- New detailed Urban-rural classification by Finnish Environment Institute SYKE

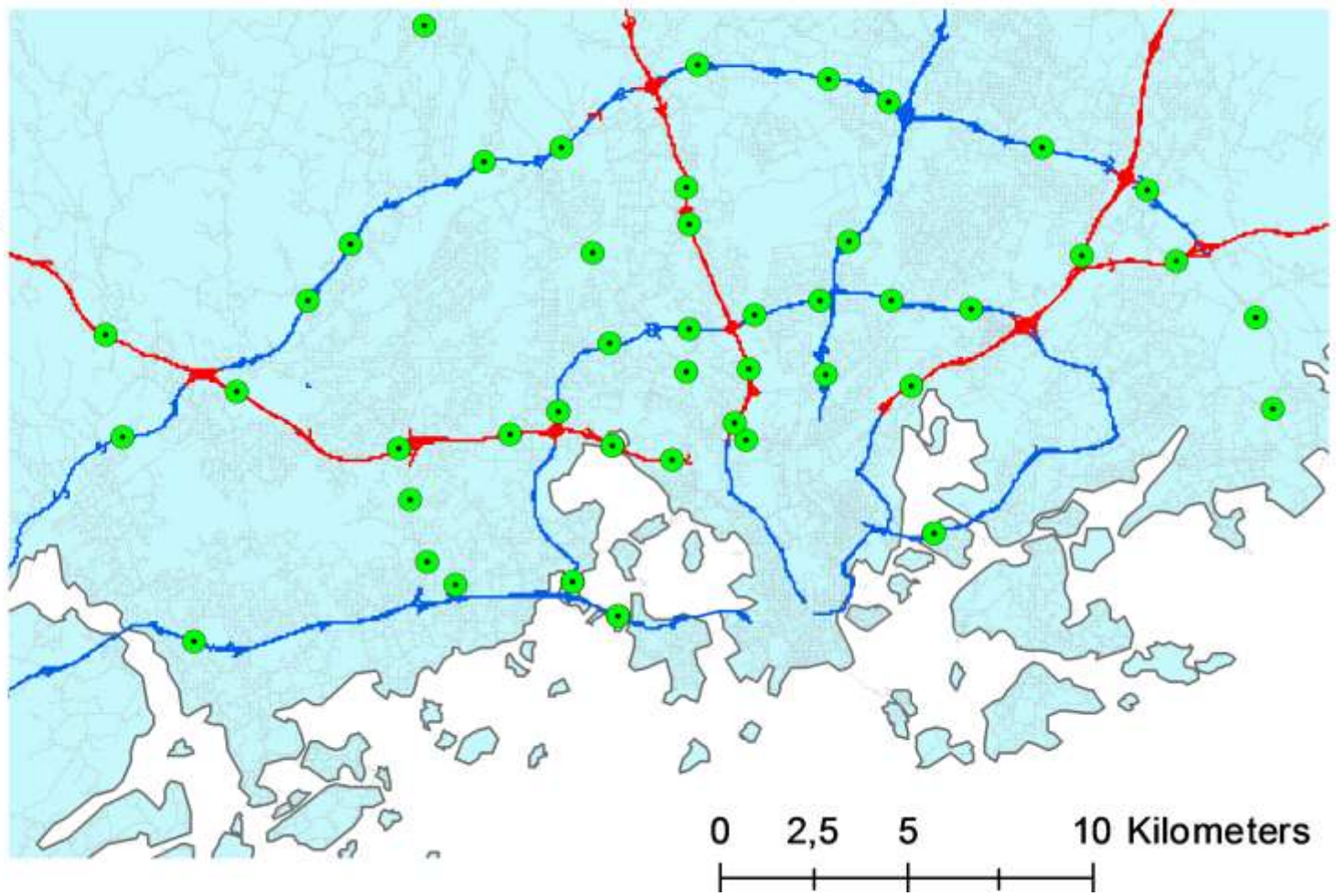


Automatic traffic measurement stations and main roads of Finland



Automatic traffic measurement stations in the metropolitan area of Helsinki

- Station
- Highway
- Trunk road

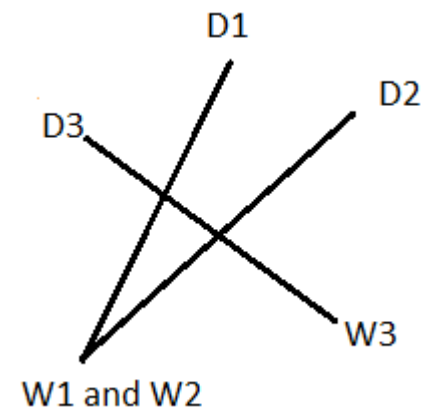


Travel-time model

1. Traffic sensor data for a 4 weeks winter period: Mon-Fri 13 Jan – 7 Feb for both directions separately between 7:00 and 8:00 only (busiest morning traffic hour).
2. generalised sensor data is compared to the winter time speed limit of the corresponding road element (avg length 188 meters). The lowest speed is taken.
3. The speed of all the other roads is estimated by using a specific road functional classification (14 classes, *strict* computational speeds). The speed classes are between 20 and 95 km/h.
 - The algorithm uses hierarchical routing moving a car away from a slow street when possible.

Pairwise computing of commuting times and distances 1/2

- 2.1 million coordinate pairs $i: ((x_{id}, y_{id}), (x_{iw}, y_{iw}))$
- Computational complexity is high
 - “takes several weeks”
- ESRI ArcGIS® and Python™
 - number of available licenses is not high
 - Network Analyst Route Solver
 - Documentation is not satisfactory but it works: common Dijkstra’s algorithm
 - with hierarchical routing (6-class functional classification: Class I main road, Class II main road, Regional road etc.)
 - impedance attribute is the travel time (of a smallest road element); accumulation attribute is the length of a route.



Pairwise computing of commuting distances 2/2

- The solution: 45,000 pairs of points (90,000 datarows) for one program run. 3 parallel runs per one standard computer. For 2 computers (2 licenses): *270,000 distances in about 3 days.*



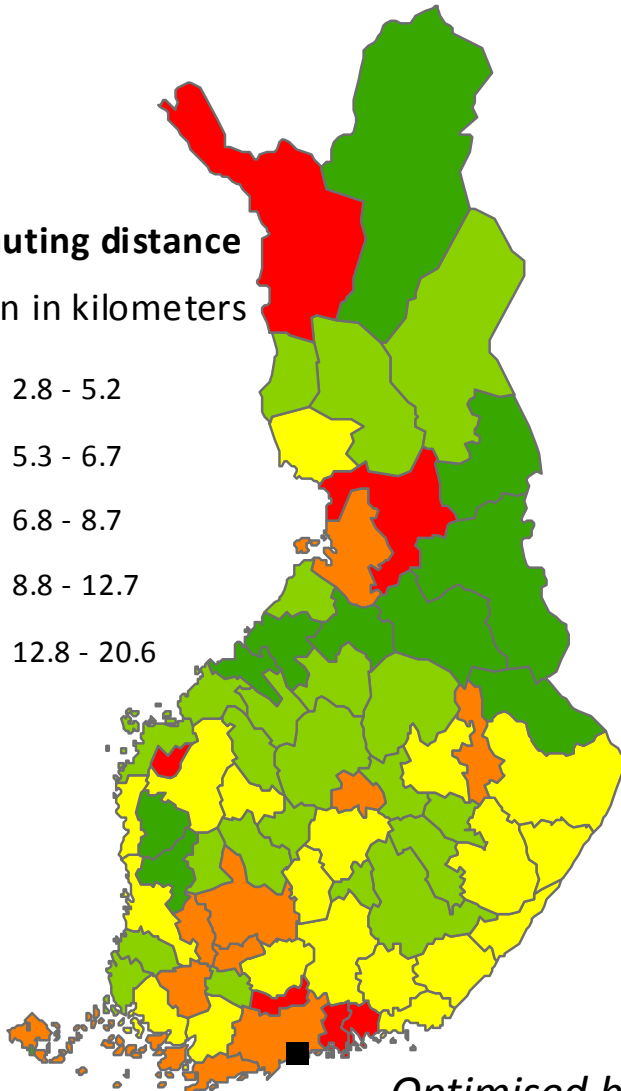
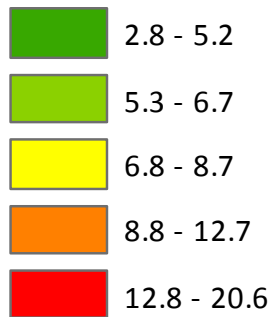
Commuting statistics

Type	Median	Mean	Q1	Q3	QCD
Linear (km)	6.10	13.43	2.08	15.40	0.76
Route (km)	8.91	17.04	3.13	20.40	0.73
Time (min.)	11.72	16.83	5.67	21.13	0.58

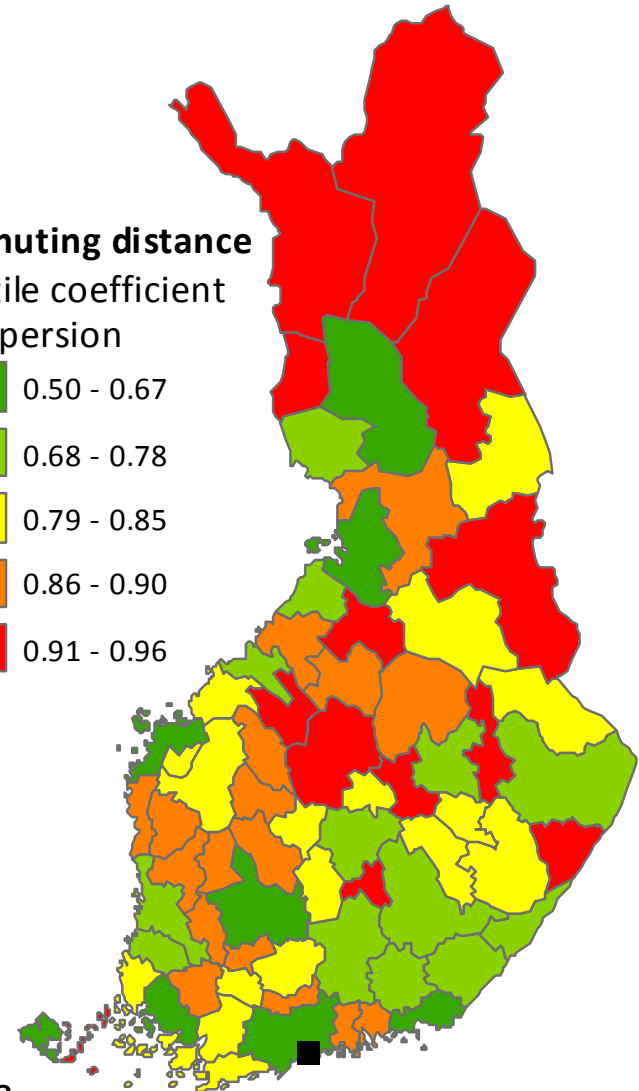
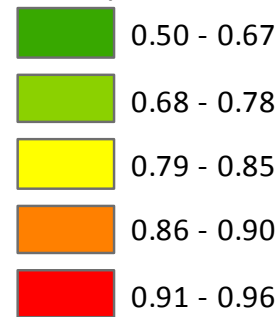
- Based on the travel time optimisation.
- $Q1 = 25\text{th percentile}$, $Q3 = 75\text{th percentile}$
- The means are of 0 – 200 km distances
- Deviation measure here:
 - $QCD = (Q3 - Q1) / (Q3 + Q1)$
 - Quartile coefficient of dispersion

Commuting distance for populations of the subregions (LAU 1)

Commuting distance
Median in kilometers



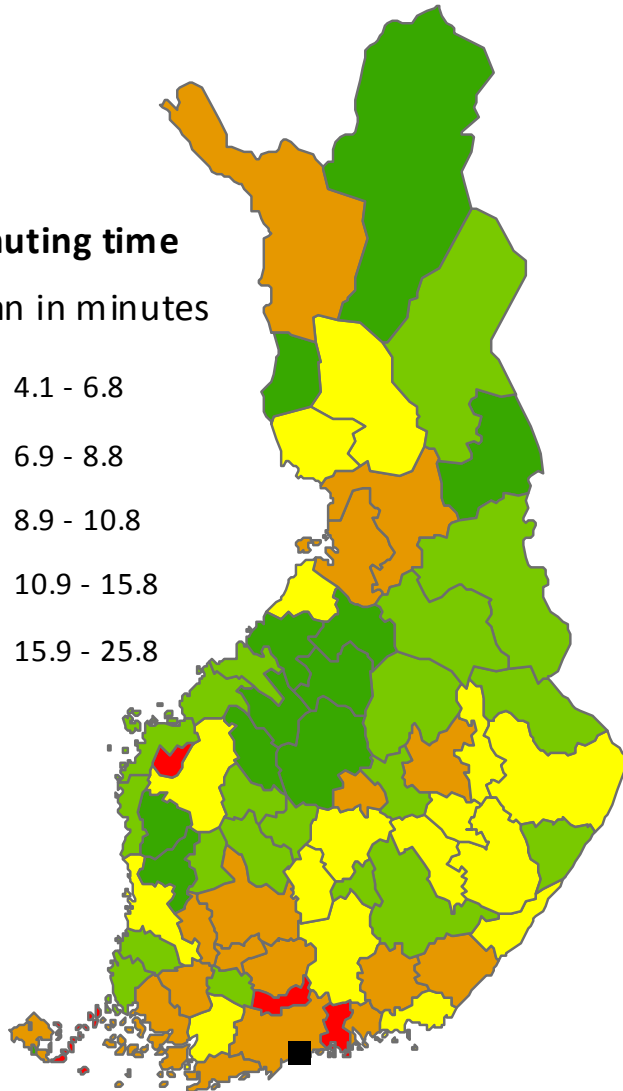
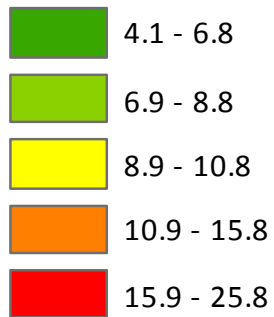
Commuting distance
Quartile coefficient of dispersion



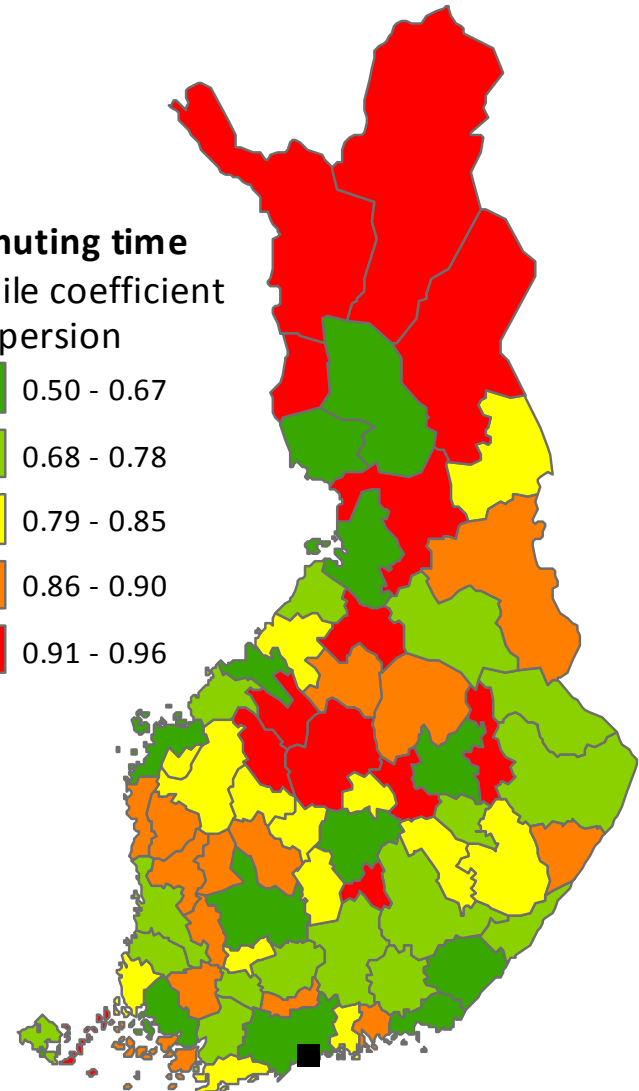
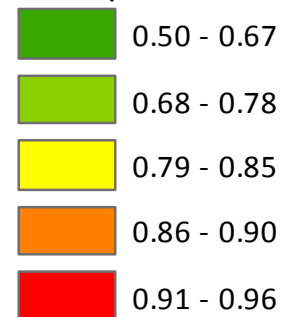
Optimised by drive time.

Commuting time for populations of the sub-regions (LAU 1)

Commuting time
Median in minutes



Commuting time
Quartile coefficient of dispersion

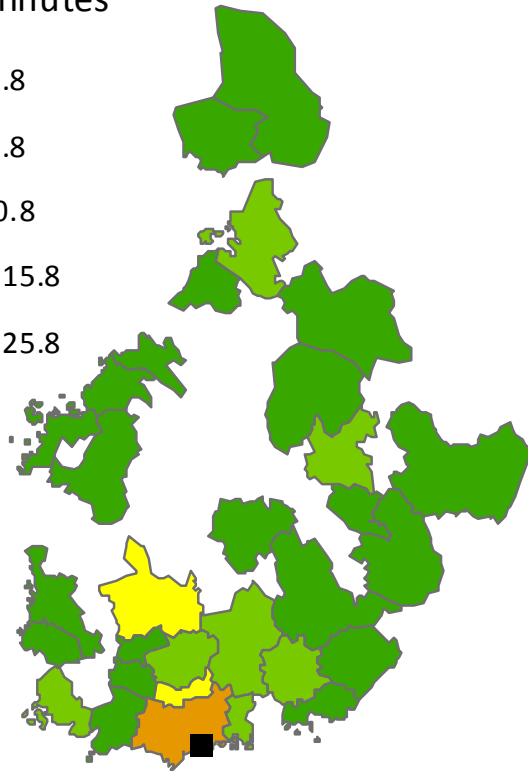
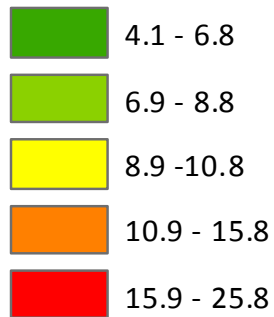


Commuting time by the Urban-rural classification

Populations in *Inner-urban areas* (left) and in *Rural areas close to urban areas* (right) by the sub-regions.

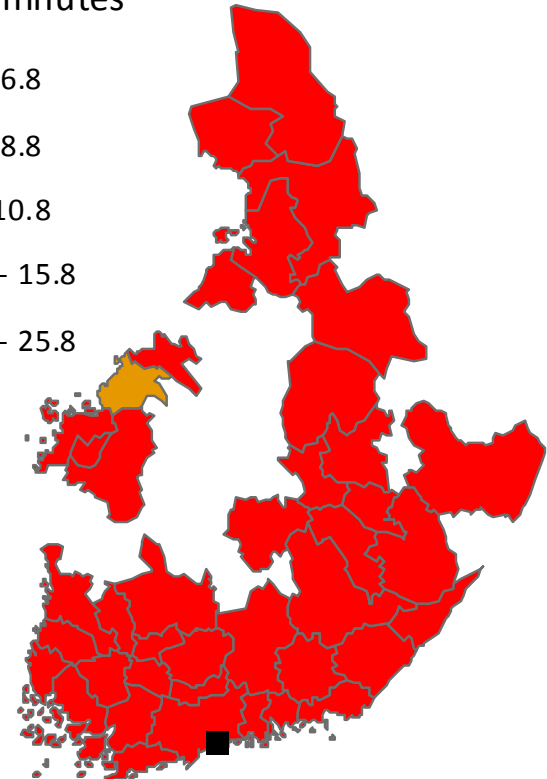
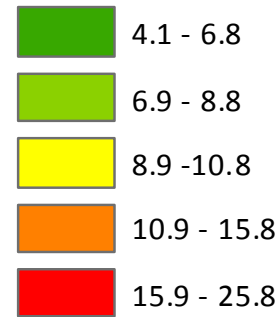
Commuting time

Median in minutes



Commuting time

Median in minutes

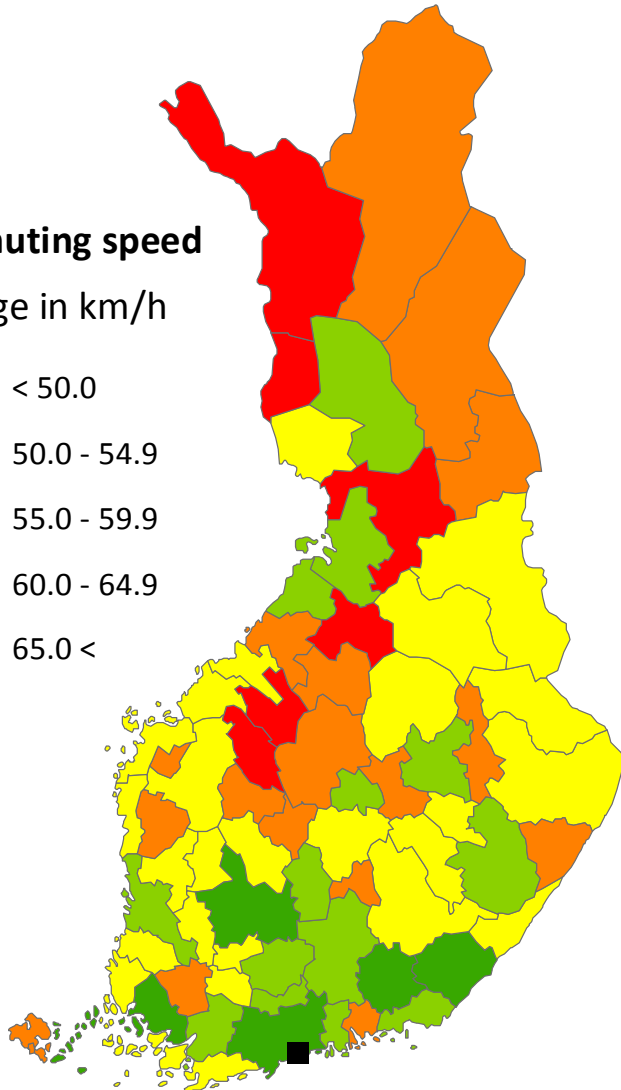
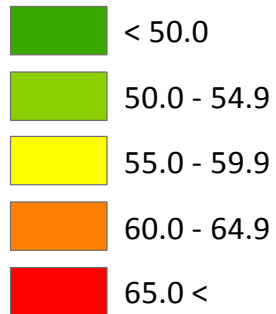


Average speed for commuting distances 10-15 km

Populations in *Rural heartland areas*:

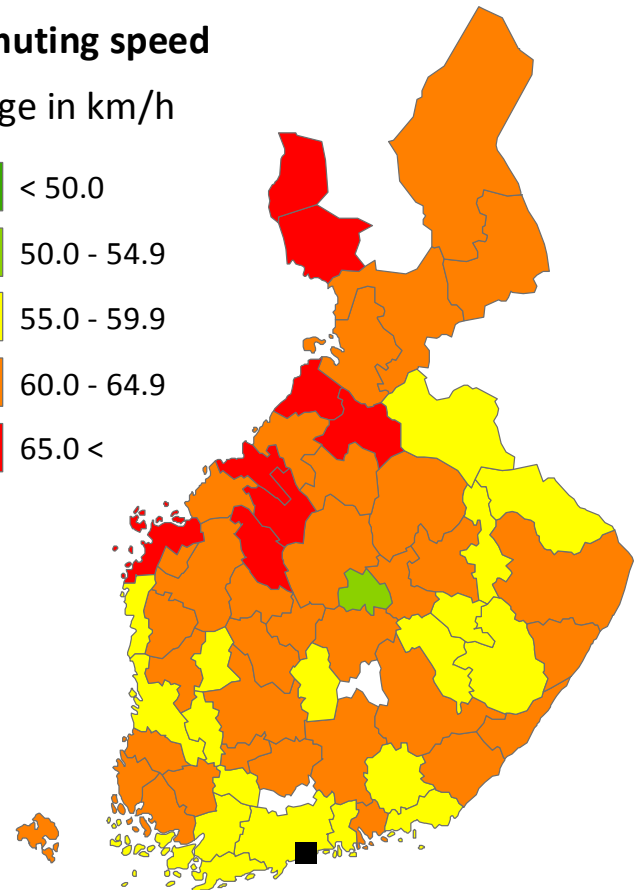
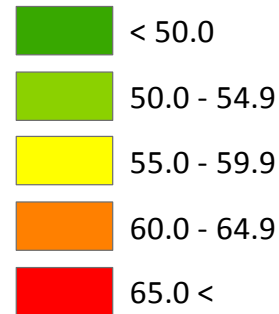
Commuting speed

Average in km/h



Commuting speed










Average in km/h





Average speed

Km/h

-  < 10
-  10.0 - 19.9
-  20.0 - 29.9
-  30.0 - 39.9
-  40.0 - 49.9
-  50.0 - 59.9
-  60.0 - 69.9
-  70.0 - 79.9
-  79.9 <








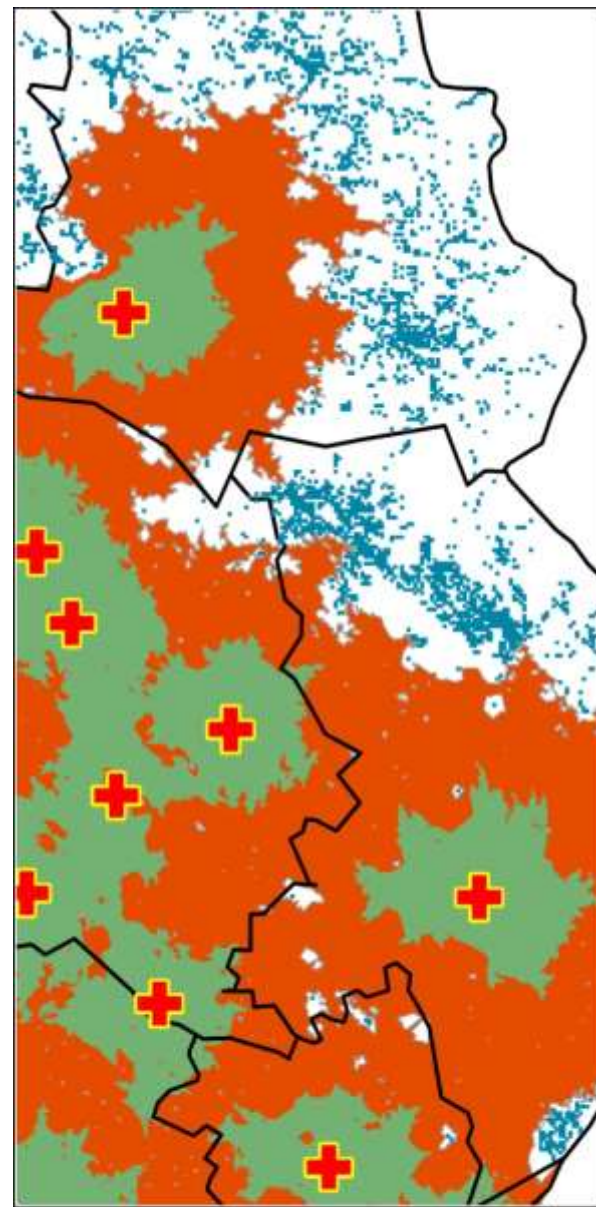
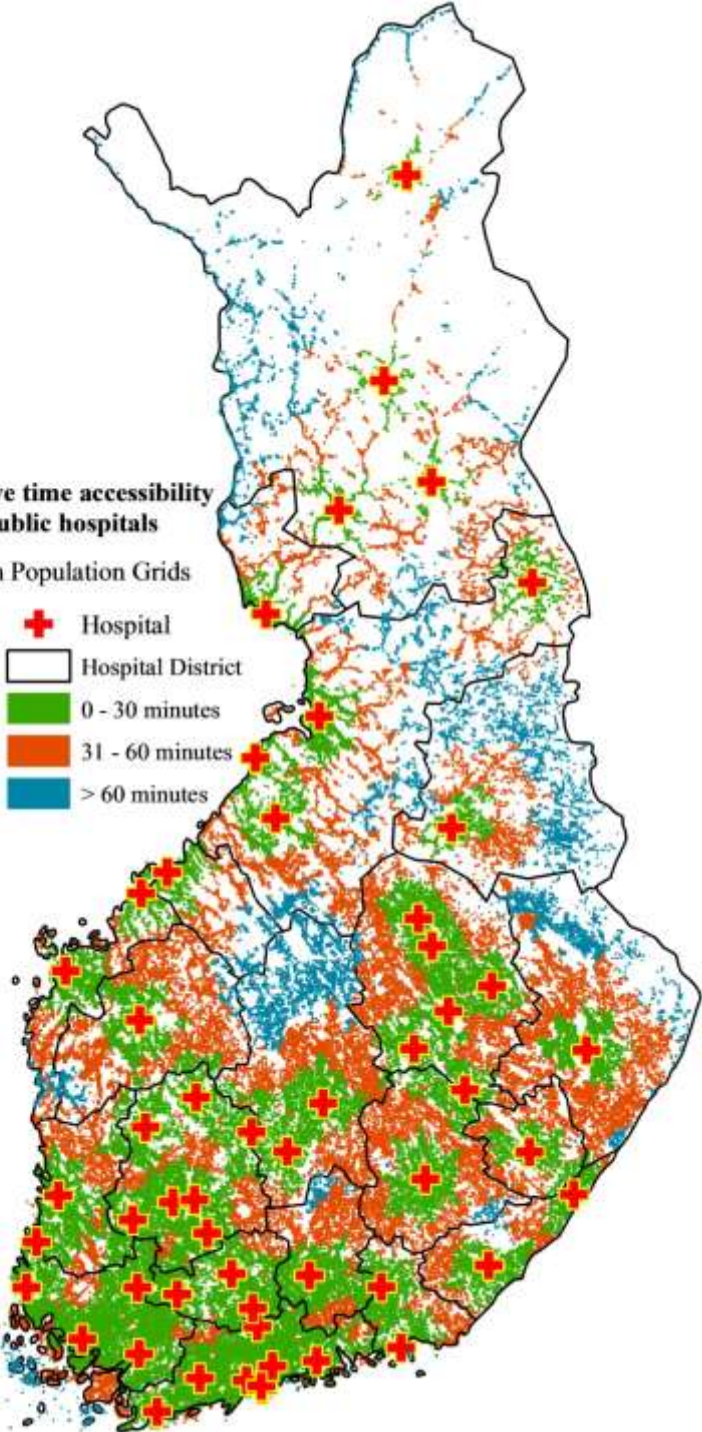
Other application examples

- 24/7 Emergency Accessibility
 - Population aggregated to 1 km x 1 km grids
 - Speed limits for each traffic element
- Elementary School Accessibility
 - Population aggregated to 250 m x 250 m grids
 - Pedestrian districts allowed, non-hierarchical

**Drive time accessibility
to public hospitals**

1 km Population Grids

-  Hospital
-  Hospital District
-  0 - 30 minutes
-  31 - 60 minutes
-  > 60 minutes



Service Area Polygons

-  30 min.
-  60 min.

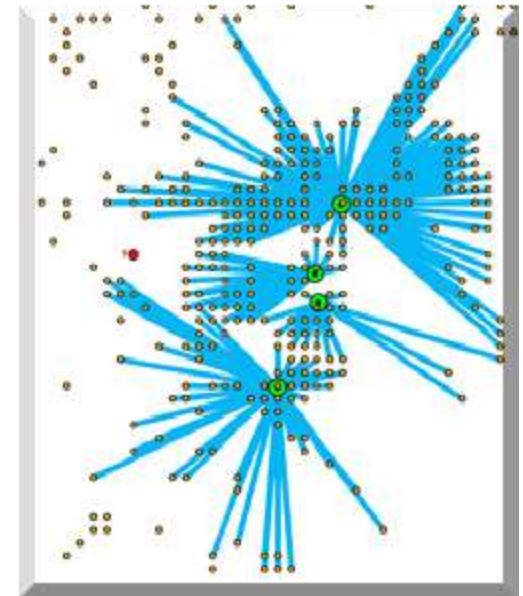
Relative 30 minutes drive time coverage by age groups

Hospital Dist.	1 – 15	16 - 64	65+	All
All	0.896	0.894	0.846	0.885
Min, Kainuu	0.591	0.581	0.519	0.570
Max, Helsinki	0.991	0.991	0.986	0.991

Relative distances to the nearest lower/upper comprehensive school

Municipality	< 1 km	< 3 km	< 5 km	Population
Helsinki lower s.	0.811	0.996	1.000	29,246
Helsinki upper s.	0.552	0.988	1.000	14,647
Espoo lower s.	0.669	0.984	0.994	18,799
Espoo upper s.	0.417	0.934	0.982	8,779

- For the permanent population aged 7 to 12 and 13 to 15 in 2012*



Further research and conclusions

- *Many accessibility challenges are related to rush hour traffic. The estimation of the commuting travel time becomes much more complex than the general 24/7 emergency accessibility. Big data helps.*
- *The extensive and detailed national road network has been proven useful in population statistics and will be seen as part of the social statistics data warehouse based applications in forthcoming years.*

Thank you!

pasi.piela@stat.fi